Imidacloprid (Merit® 2F) increases the growth of the poplar (*Populus nigra*) clone NC5271 by increasing total leaf area

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Summary

Previous studies with agronomic crops suggest that the neonicotinoid insecticide imidacloprid can have direct positive physiological effects on plant growth and stress tolerance that are independent of its insecticidal properties, but few studies have tested this effect on woody plants. In a controlled-environment experiment, we tested effects of imidacloprid on growth, biomass allocation, and gas exchange of the poplar (*Populus nigra*) clone NC5271. In a factorial experiment, plants were grown under three fertility (high, medium, and low) and two irrigation regimes (optimal, moderate drought). Half the replicates in each treatment were also treated with imidacloprid (Merit® 2F). As fertility increased, so did plant growth rate, total leaf area, and total biomass, while percent root mass decreased. Moderate drought stress had opposite effect, decreasing growth, total leaf area, and total biomass, while increasing percent root mass. Imidacloprid increased plant growth and total biomass. The positive growth effect was due to increased total leaf area, as repeated measures ANOVA showed that imidacloprid actually had a small negative effect on light-saturated net photosynthesis. The positive effect of imidacloprid on plant growth was independent of fertility or irrigation level, occurring across all environments. These data are consistent with the hypothesis that imidacloprid can have beneficial physiological effects on woody plants that are independent of its insecticidal properties

Introduction

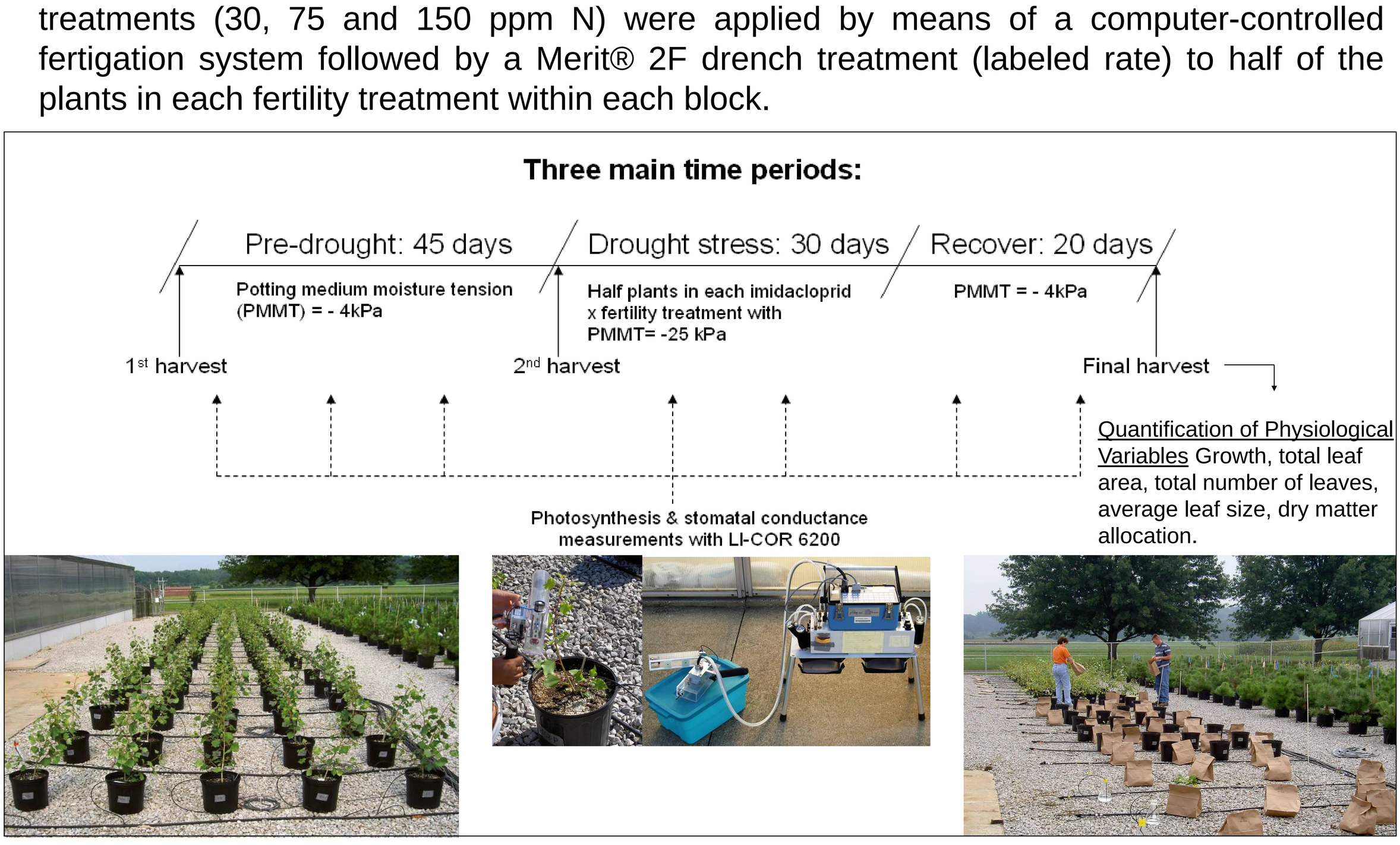
Recent studies suggest that the neonicotinoid insecticide imidacloprid can induce systemic resistance pathways in agronomic plants, stimulate faster growth, enhance recovery from abiotic stress recovery, and increase yield when applied to plants growing under sub-optimal environmental conditions (Oosterhuis et al. 2003; Gonias et al. 2003; Thielert, 2006). Few studies have addressed these effects in trees.

Objective

Determine effects of Merit® 2F on physiology and stress tolerance of the black poplar (*Populus nigra*) clone NC5271 grown under three different fertility and two irrigation regimes.

Methods

From March until June 2006, cuttings of the black poplar were rooted, grown and transferred to an outdoor nursery when they were sorted into five blocks. Three fertilization treatments (30, 75 and 150 ppm N) were applied by means of a computer-controlled fertigation system followed by a Merit® 2F drench treatment (labeled rate) to half of the plants in each fertility treatment within each block.



Results and Discussion

By the time of final harvest, Merit® 2F had significantly increased plant growth, as indicated by total plant biomass, total leaf area and total leaves on treated plants, which indicates that new leaves were formed at a faster rate (Fig.1). There was no effect of Merit® 2F on mean size of individual leaves nor on percent root mass, indicating that Merit® 2F had similar positive effects on above and below ground growth (Fig. 2.).

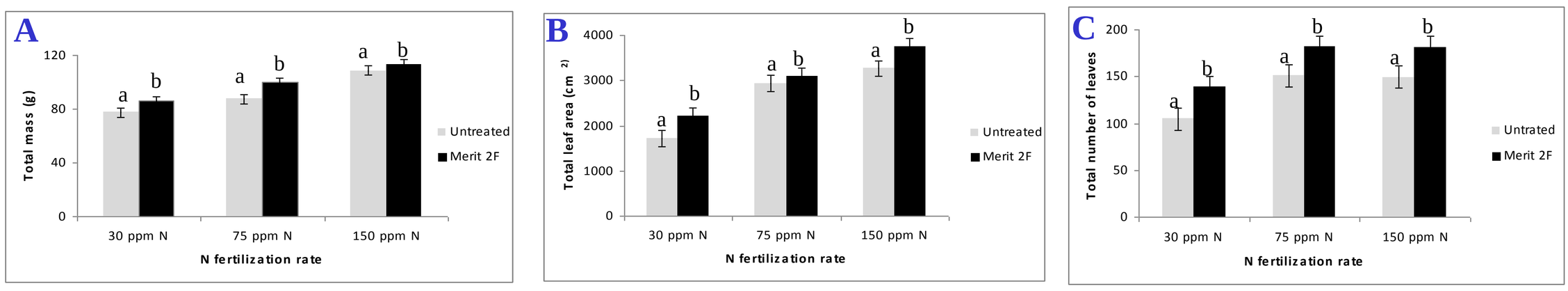


Figure 1. Effects of Merit® 2F and fertilization rate on growth and biomass allocation (A), total leaf area (B), and total number of leaves (C) of hybrid poplar, *Populus nigra* (least square mean ± SE). Means within a fertility treatment with the same letter are not significantly different (ANOVA followed by LSD test, $p<0.05$).

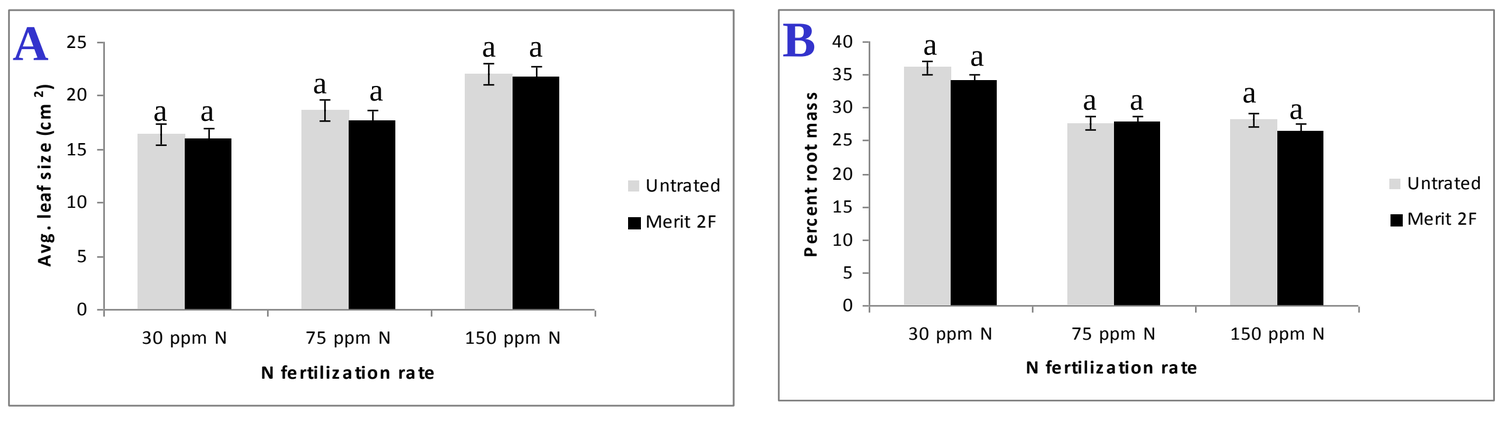


Figure 2. Effects of Merit® 2F and fertilization rate on leaf size (A) and percent root mass (B) of hybrid poplar, *Populus nigra* (least square mean ± SE). Means within a fertility treatment with the same letter are not significantly different (ANOVA followed by LSD test, $p<0.05$).

There were no significant interactions between Merit® 2F and either the drought or fertility treatments on total plant mass, total leaf area, or total No. of leaves indicating that the positive effect of imidacloprid on plant growth were independent of fertility level (Fig.1) and water availability (Fig.3).

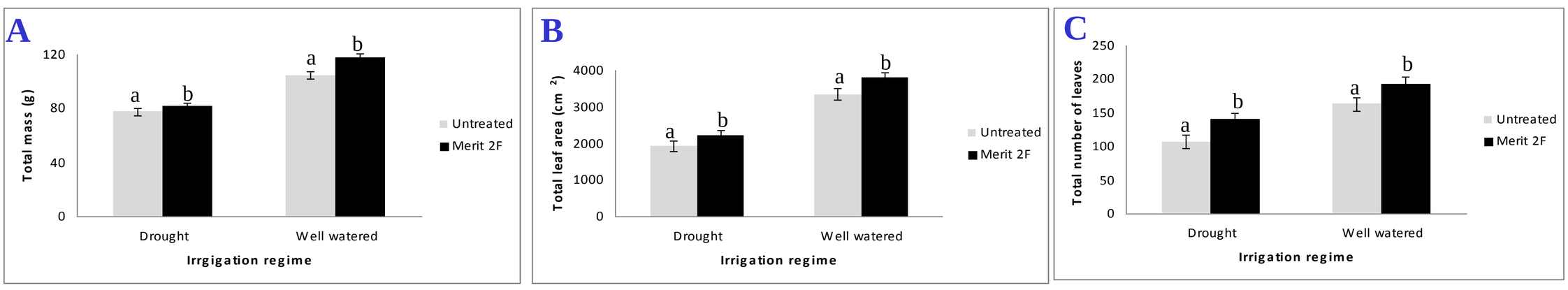


Figure 3. Combined effects of Merit® 2F and water availability on growth and biomass allocation (A), total leaf area (B), and total number of leav

Merit® 2F had an small overall negative effect on photosynthesis per unit leaf area and stomatal conductance over the course of the entire experiment (Table 1).

	Photosynthesis (µmol CO2 m^{-2} s^{-1})		Stomatal Conductance (cm s^{-1})	
Date	Merit 2F	Untreated	Merit 2F	Untreated
15-Jun	5.7 ± 0.5a	5.8 ± 0.5a	0.30 ± 0.02a	0.34 ± 0.02a
6-Jul	5.7 ± 0.4a	6.0 ± 0.4a	0.57 ± 0.06a	0.69 ± 0.06a
17-Jul	4.8 ± 0.4a	5.8 ± 0.4a	0.79 ± 0.06a	0.84 ± 0.06a
31-Jul	8.4 ± 0.4a	8.7 ± 0.4a	2.21 ± 0.13a	2.48 ± 0.13a
11-Aug	8.3 ± 0.5a	9.4 ± 0.5a	0.79 ± 0.07a	0.88 ± 0.07a
21-Aug	7.1 ± 0.4b	9.2 ± 0.4b	1.08 ± 0.03a	1.25 ± 0.03a
31-Aug	8.7 ± 0.4a	9.2 ± 0.4a	0.99 ± 0.06a	1.06 ± 0.06a

Table 1. Effect of Merit® 2F on photosynthesis and stomatal conductance of hybrid poplar, *Populus nigra* (least square mean ± SE). Means within a column followed by the same letter are not significantly different (Repeated measures ANOVA, $p<0.05$).

Conclusions

- Imidacloprid (Merit® 2F) increased tree growth through physiological effects that are independent of its insecticidal properties.
- Growth enhancing effect of imidacloprid can be attributed to increased total leaf area and total number of leaves (no effect on leaf size; slight negative effect on photosynthesis).
- The positive effect of imidacloprid was expressed in stressful and optimal environments.

Literature Cited

Gonias, E.D.; D.M. Oosterhuis; A.C. Bibi; R.S. Brown. 2003. Yield, growth and physiology of Trimax™ Treated Cotton. Summaries of Arkansas Cotton Research 2003. pp. 139-144.

Oosterhuis, D.M.; R.S. Brown. 2003. Effects of Trimax™ insecticide applications under water-deficit stress condition on lint yield and physiology of field-grown cotton. In: Proceedings, Beltwide Cotton Conferences. National Cotton Council, Memphis, Tenn. CD-ROM.

Thielert, W. 2006. A unique product: The story of the imidacloprid stress shield. Pflanzenschutz-Nachrichten Bayer 59:73-86.